CHAPTER 7

Energy for Life

Getting Ready...

- Why are plants considered the basis for life?
- Do some people need more energy than others to lead a healthy life?
- How do energy requirements change throughout a person's life?

Agriculture is a major part of the Canadian economy. Fresh fruit and vegetables are important sources of energy.

Science Log

Could life exist without the Sun? For example, could we replace the Sun's energy with artificial energy sources? Discuss this question with a partner and record your thoughts.

Life on Earth could not exist without plants. The ability of plants to make oxygen made it possible for oxygen-breathing animals to develop on this planet. Plants convert carbon dioxide in the atmosphere into oxygen.

As well as this, they capture energy from the Sun and use it to produce food. This means that animals that eat roots, stems, leaves, and the meat of other animals all depend on plants every day.

In this chapter you will examine how plants capture energy from the Sun and convert it into potential energy. You will also see how animals use this food to obtain energy for themselves. You will examine carbohydrates, fats, and proteins, and see how each is used as a source of energy. You will also analyze how human energy needs change from infancy to old age.

Hydroponics is growing plants without soil. Plants in constant contact with water grow well under artificial light.

What You Will Learn

In this chapter you will learn:

- how plants capture energy from the Sun in the food they produce
- how the food we eat provides energy
- how our bodies use energy stored within three nutrient groups
- how the amount of energy humans need changes according to their stage of growth and activity level

Why It Is Important

- Our bodies are unable to convert solar energy to the energy we need for life. The energy we use can be traced back to the energy trapped by plants in glucose. Our energy level and our health depend on the food we consume, and good health all depends on plants. By the end of the chapter you may find yourself thanking the plants you meet.

Skills You Will Use

In this chapter you will:

- trace the pathway of energy captured from the Sun
- evaluate the nutrient value of food choices
- investigate some foods and their energy content

Starting Point ACTIVITY

Using Glucose for Energy

Safety Precautions

- Clean up the work area, and wash your hands thoroughly at the end of the activity.

What You Need

hot water bath	250 mL water
4 small test tubes	yeast suspension
glucose solution	Benedict's solution
eye dropper	marking pen

What to Do

1. Use the pen to label the test tubes 1–4.
2. Place 1 mL of water and 20 drops of Benedict's solution in test tube 1. Place the test tube in the hot water bath for 2 minutes. Record the colour of the solution before and after heating.
3. Add 1 mL of sugar solution, 1 mL of water, and 20 drops of Benedict's solution to test tube 2. Place the test tube in a hot water bath for 2 minutes. Record the colour of the solution before and after heating.
4. Add 1 mL of sugar solution, 1 mL of water, 20 drops of Benedict's solution, and 1 mL of yeast to test tube 3. Immediately place this test tube in the hot water bath. Record the colour of the solution before and after heating.
5. Place 1 mL of sugar and 2 mL of yeast solution in test tube 4. Place this test tube in a warm place and leave it for at least 15 minutes. After 15 minutes, add 20 drops of Benedict's solution and place the test tube in the hot water bath. Record the colour of the solution before and after heating.

7.1 Nature's Energy Conversions

Try This!

Review the Math Connects on pages 53 to 54 in Chapter 3. Use the information there to help you check whether the equation for photosynthesis is balanced. Be sure to show your thinking and calculations.

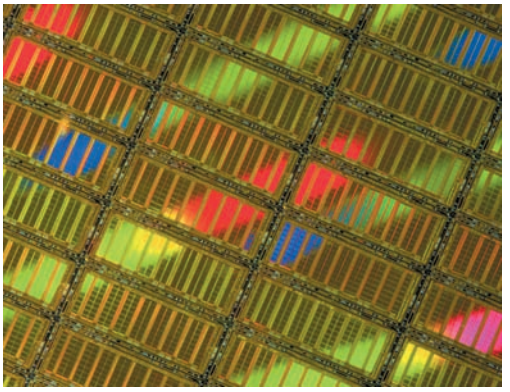


Figure 7.1 Alberta's wheat fields are a major source of natural energy. Chlorophyll in the wheat plants captures the Sun's energy and converts it into chemical energy. This is stored in glucose, which is a form of carbohydrate. Scientists have copied this process in solar cells (on right), which convert the Sun's energy into electric energy.

Disc CONNECT

To learn more about different types of energy conversions, load the student CD-ROM onto your computer. Launch the **Energy Transformations** applet and follow the instructions.

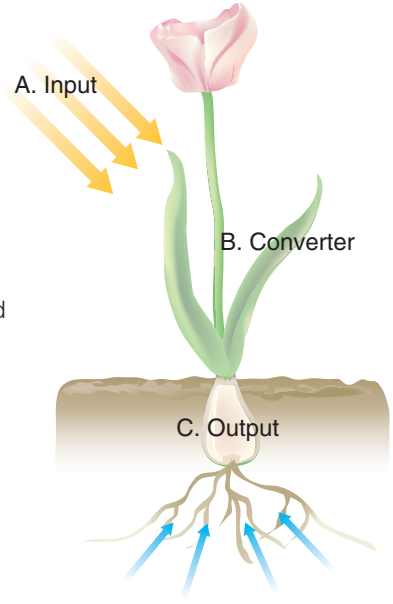
Many homes have solar cells that convert energy from the Sun into electric energy. The model and prototype for this technology was plants.

The cells of green plants have special parts that capture solar energy and convert it to energy which plants can use. These cell parts are called **chloroplasts**. Chloroplasts contain **chlorophyll**, which is a green-coloured chemical that assists in converting carbon dioxide and water into glucose and oxygen. This process is referred to as **photosynthesis**. The chemical reaction equation for photosynthesis is shown below. Study the equation, and then trace the steps of photosynthesis in Figure 7.2.

Photosynthesis

$$\text{carbon dioxide} + \text{water} + \text{light energy} \rightarrow \underset{\text{(chemical energy)}}{\text{glucose}} + \text{oxygen}$$

$$6CO_{2(g)} + 6H_2O_{(l)} + \text{light energy} \rightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$$



A. The ingredients for photosynthesis are water from the soil, energy, energy from the sun, and carbon dioxide from the air.

B. Chlorophyll in chloroplasts traps solar energy needed to combine water and carbon dioxide into glucose and oxygen.

C. Glucose is a form of carbohydrate. It is stored in plants. Oxygen is released into the air.

Glucose, a sugar, is a simple carbohydrate that is rich in chemical energy which plants and animals can use. Plants manufacture and store this chemical potential energy in their stems, leaves, and roots. Our bodies use carbohydrates as a source of energy.

READING Check

What is photosynthesis?

Figure 7.2 A plant captures solar energy to manufacture carbohydrates.

Cellular Respiration

Cellular respiration is a process used by all plant and animal cells to obtain energy from food. All cells use energy from cellular respiration to maintain life processes.

The chemical reaction equation for cellular respiration is shown below. Study the equation, then compare it to the equation for photosynthesis. What do you notice?

Glucose is the main source of energy for all cells. Cells also get energy from proteins, fats, and other food molecules.

Figure 7.3 Our bodies cannot capture energy directly from the Sun. Energy is transferred to our bodies when we eat green plants or when we eat the meat of animals that have eaten green plants.

Cellular Respiration

glucose	+	oxygen	→	carbon dioxide	+	water	+	energy
$C_6H_{12}O_{6(s)}$	+	$6O_{2(g)}$	→	$6CO_{2(g)}$	+	$6H_2O_{(l)}$	+	energy

Cellular respiration takes place in cells in specialized organelles called the mitochondria. Mitochondria are the "power plants" of the cell. In order to provide fuel to this power plant, humans must consume chemical potential energy from plants and animals.

READING Check

Why is cellular respiration important?

Two Energy Conversions

It takes two energy conversions for Sun power to get to you so you can do the activities you enjoy.

1. The equation below shows the energy conversion in plants.

input energy	→	converter	→	output energy
solar energy	→	chloroplasts in plant leaf	→	chemical potential energy (glucose, a form of carbohydrate)

2. Animals convert plant energy using the energy conversion that follows.

input energy	→	converter	→	output energy
chemical potential energy (glucose)	→	(mitochondria in cells)	→	muscular activity in muscle cells (kinetic energy)

DidYouKnow?

When you work hard at running or skiing, your cells release energy from glucose. Since the cells do not get all the oxygen they need when you are working hard, they cannot release all the energy from glucose. As a result, cells make a waste product called lactic acid. When lactic acid is produced, muscles tire quickly, and become stiff and painful.

CONDUCT AN

INVESTIGATION 7-A

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Balloons Simulate Respiration

Problem

What affects the rate of cellular respiration?

Prediction

Yeast is a living organism that depends on cellular respiration in order to grow. Look at the four solutions listed under Materials. How will the rate of respiration of yeast be affected by each of these liquids? How will it be affected by water? Justify each of your predictions.

Safety Precautions

- If any chemical touches your eyes or skin, flush the area with water. Ask another student to notify the teacher immediately.
- Turn heat sources off when not in use.
- Make sure that the room is well ventilated when using bleach and ammonia solutions. Do not mix them.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Apparatus

500 mL beaker
thermometer
scissors
marking pen
6 test tubes
test tube rack
graduated cylinder
balance
100 mL beaker
stir stick
eye dropper

Materials

warm tap water (40°C)
masking tape
rapid rise yeast
sugar
vinegar solution
liquid bleach solution
ammonia solution
liquid plant fertilizer solution
6 balloons
matches
wooden splint

Procedure

1. Cut six small squares from the masking tape. Label each test tube — numbers 1 to 6.
2. Use the balance to measure 4 g of yeast.
3. Pour about 300 mL of warm tap water (40°C) into the 50 mL beaker.
4. Use the graduated cylinder to measure 50 mL of the warm water.
5. Pour 50 mL of warm water and 4 g of yeast into the 100 mL beaker. Let stand for one minute, and then stir thoroughly.
6. Use the graduated cylinder to measure 5 mL of the yeast mixture. Pour 5 mL of the yeast mixture into each of the six test tubes.
7. Use the balance to measure five amounts of sugar, 1 g each.
8. Add substances to the test tubes as indicated in the table. Flush the eye dropper with water before picking up each substance.

Yeast Solutions

Test Tube #					
1	2	3	4	5	6
5 mL yeast mixture	5 mL yeast mixture 1 g sugar	5 mL yeast mixture 1 g sugar 25 drops vinegar solution	5 mL yeast mixture 1 g sugar 25 drops bleach solution	5 mL yeast mixture 1 g sugar 25 drops ammonia solution	5 mL yeast mixture 1 g sugar 25 drops fertilizer solution

10. Inflate and deflate each balloon three times. Empty the air from the balloons.
11. Stretch the mouth of a balloon over the top of each test tube.
12. Put the test tubes together in the 500 mL beaker of warm tap water.
13. Observe for 10 minutes. Record changes in each test tube and how each balloon changes.

Analyze

1. Which of the test tubes served as a control for the investigation?
2. Which test tube collected the most gas?
3. Which test tube collected the least gas?
4. What happened to the yeast in each test tube?

Conclude and Apply

5. From what you know about cellular respiration, which gas do you think was collected in the balloons?
6. Draw a picture of the test tubes as a record of your results. Label each test tube to identify the contents.
7. What factors speed up the rate of respiration?
8. What factors slow or stop respiration?
9. If you were mixing a solution that would speed up respiration, what ingredients would you include?

Extend Your Knowledge

10. Light a wooden splint. Blow out the flame so the splint is glowing. Take the gas that is captured in one of the balloons and release it over the splint. Alternatively, bubble the gas through limewater. Record what happens.

Try This!

Review the note on Two Energy Conversions at the bottom of page 119. Copy lines (a), (b), and (c) into your notebook. Use the information on page 119 to complete line (c) in your notebook. The equations explain what conversion was taking place in Test Tube 2. For line (c), identify:

- what was put into Test Tube 2 to provide chemical potential energy
- what converted that chemical potential energy
- the evidence of growth

(a) input energy → converter → output energy

(b) chemical potential energy → a living organism such as yeast → growth

(c) _____ → _____ → _____

Energy Conversion: Plants to Animals

During all energy conversions, a certain amount of energy becomes waste energy. During walking, for example, the body does not convert 100 percent of the chemical energy in glucose to kinetic energy. Some energy is lost. The most common type of waste energy is thermal energy lost to the surrounding environment.

Your body produces thermal energy to keep your body warm and releases the excess as waste energy. For example, have you noticed that you get warmer (that is, release more thermal energy) when you increase your physical activity? Similarly, the temperature of a cool room increases when more and more people enter. The source of heat is the thermal energy being released by the people's bodies.

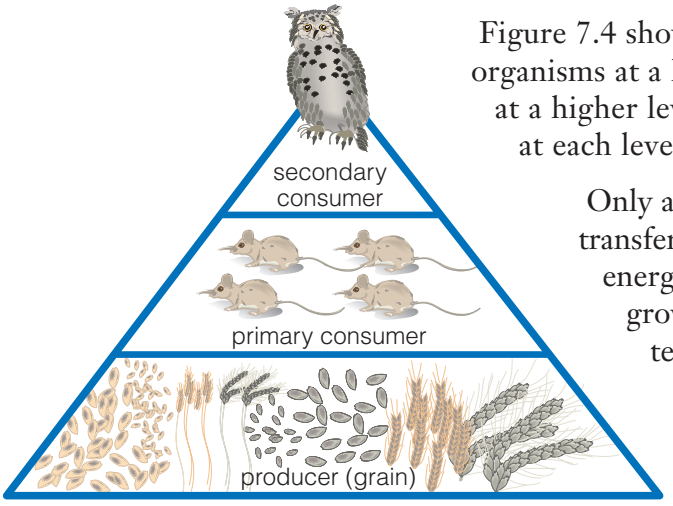


Figure 7.4 This energy pyramid demonstrates that it takes many organisms at lower levels to support fewer and fewer organisms at higher levels. The mouse that eats wheat gets only 10 percent of the energy the wheat captured from the Sun. The owl, the secondary consumer, gets only 10 percent of the energy the mouse got from the wheat.

Figure 7.4 shows an ecological pyramid. Note that it takes many organisms at a lower level to support a small number of organisms at a higher level. This is because of the amount of waste energy at each level.

Only about 10 percent of the energy in one level is transferred to the next level. The other 90 percent of the energy is used for normal life functions such as movement, growth, and reproduction, and to keep the body temperature constant in warm-blooded animals. The energy that stays in the organism is eventually released by decomposers after the organism dies. Eventually, this energy provides the energy needed for the growth of new organisms.

READING Check

Why is the amount of useful output energy always less than the amount of input energy?

Key Terms

- chloroplasts
- chlorophyll
- photosynthesis
- cellular respiration

Check Your Understanding

1. How do animals capture energy from the Sun?
2. Identify the input energy, converter, and two output energies involved when a student eats a hamburger.
3. What is cellular respiration? Why is it important for humans?
4. As you go higher on the pyramid of energy, is there more or less energy available? Why is this so?

7.2 The Need for Energy

The snow boarders in the photograph use several kinds of energy as they go down the hill. One major use of energy in our bodies is in maintaining **homeostasis**. No matter what is happening outside the body, homeostasis maintains the body's internal environment. Despite the chill of a cold Canadian winter, for example, human bodies try to hold a steady temperature of approximately 37°C.

Figure 7.5 Think of the types of energy you use when snowboarding. Muscular energy keeps you balanced on the snowboard. Energy used by your brain allows you to think quickly to avoid falls and other accidents. Athletes make careful food choices to make sure they have a ready source of energy when they need it.

Your body has many adaptations that allow it to stay at this temperature, regardless of the temperature of the surrounding environment.

- When your body is too warm, for example, blood vessels are brought close to the skin's surface. Heat can then transfer out quickly.
- Perspiration is another way the body cools. Moisture is moved outside the skin. Evaporation of this moisture cools the body.
- Shivering helps to warm your body. Vibrating muscles burn more energy. The chemical potential energy in glucose is converted to the kinetic energy used in shivering, and thermal energy is released.
- To protect itself from getting too cold, the human body can direct less blood to limbs and more to the core. To do this, blood vessels near the surface constrict. Less blood can get close to the outside, so less thermal energy is lost to the environment.

The rate at which a human body uses energy is referred to as **metabolism**. Someone with high metabolism has high energy needs. These people may be able to eat a lot but still not gain weight. That is because the energy from their food is either used by the body during digestion, activity, and excretion (getting rid of wastes), or is released, usually as thermal energy. People with low metabolism have lower energy needs.

Off the Wall

The human body gives off about 100 calories of heat per hour. This is a little more than the heat given off by a 100 watt electric light bulb in one hour.

Try This!

Interview emergency response workers about the techniques they use to treat people suffering from hypothermia or hyperthermia.

READING Check

Why is homeostasis necessary?

DidYouKnow?

A fever that raises body temperature too high (for example, over 42°C) can cause organ damage. It is particularly important to monitor and treat fever in infants and small children.

INVESTIGATION 7–B

SKILLCHECK
- Initiating and Planning
- ✸ Performing and Recording
- ✸ Analyzing and Interpreting
- Communication and Teamwork

Daily Temperature Changes

Hour	Temperature	Hour	Temperature
1	36.6	13	37.2
2	36.4	14	37.4
3	36.3	15	37.0
4	36.0	16	36.8
5	35.7	17	37.8
6	35.7	18	37.8
7	36.0	19	37.4
8	36.6	20	37.0
9	37.0	21	37.0
10	36.6	22	36.9
11	36.6	23	36.8
12	36.8	24	36.8

Think About It

Your temperature changes constantly throughout each day. Normal body temperature for a healthy individual is between 36.2°C and 37.2°C. But the body temperature of a healthy person can fluctuate as much as one or two degrees. When a person is sleeping, their body temperature is usually coolest between 4:00 A.M. and 5:00 A.M. The body is warmest during hard physical exercise.

What to Do

1. Use the information in the table to draw a line graph.
   - The rectangle for the graph should be 26 units long and 25 units high.
   - Place hours on the horizontal axis (*x*-axis).
   - Make the vertical axis (*y*-axis) from 35.5°C to 38.0°C. Allow space for every tenth degree.

Analyze

1. At which hour or hours does the lowest temperature occur? What is this person probably doing at this time?
2. Examine your graph. At which point do you think this student is participating in a rigorous sport? Explain your answer.
3. **(a)** Assume the lowest temperatures begin at 4:00 A.M. Develop a time line below the horizontal axis (*x*-axis) that shows at which time of day each temperature was taken.

   (b) Is there a relationship between normal eating times and temperature? What do you think could account for these changes?

Key Terms

homeostasis
metabolism

Check Your Understanding

1. How do homeostasis and metabolism work together to keep an organism alive?
2. List and explain four methods that an organism such as a cat uses to stay warm on cooler days.
3. Many exercise and weight-loss programs encourage speeding up an individual's metabolism. Explain how a person could lose weight by increasing their exercise routine.

7.3 Sources of Energy

Food is the fuel that keeps humans warm, active, and alive. The main source of energy for the human body is a simple **carbohydrate** called glucose. Through cellular respiration, glucose is broken down to provide energy that powers the body's metabolism. If more glucose is taken in than is immediately needed, the extra is converted to **glycogen**, a starch-like substance. Glycogen is stored in the liver and muscles. When we need energy, glycogen is converted back into glucose.

Health experts recommend that we take in 55 to 65 percent of our daily calories in carbohydrates. Sometimes, people will take more. For example, many athletes get their energy from what is referred to as "carbo. loading." This refers to eating a large volume of carbohydrates a day or two before the event. These are stored in the liver as glycogen and can be drawn on quickly when energy is needed for endurance events.

People who go on special diets tend to alter the amount of carbohydrate, fat, and protein they eat because these nutrients provide the energy that keeps our bodies going. Carbohydrate is the most direct source of energy.

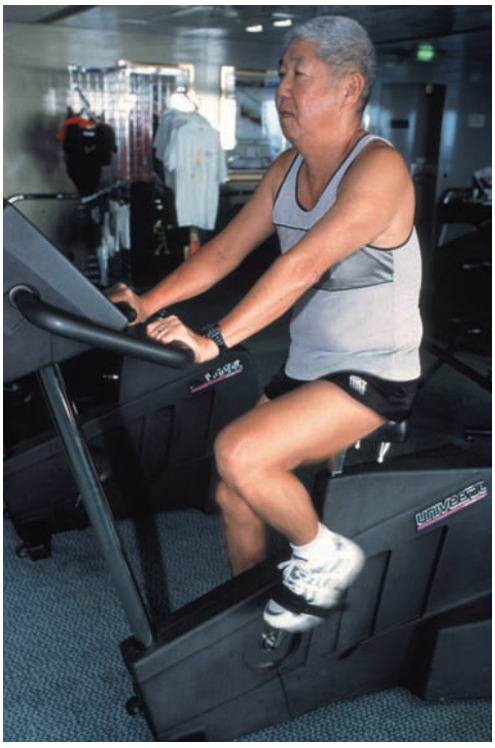


Figure 7.6 Regardless of your age or build, exercise will increase your metabolism. This increase can be measured by the amount of heat the body produces due to increased chemical reactions. Even after exercise, metabolism stays high for a short period.

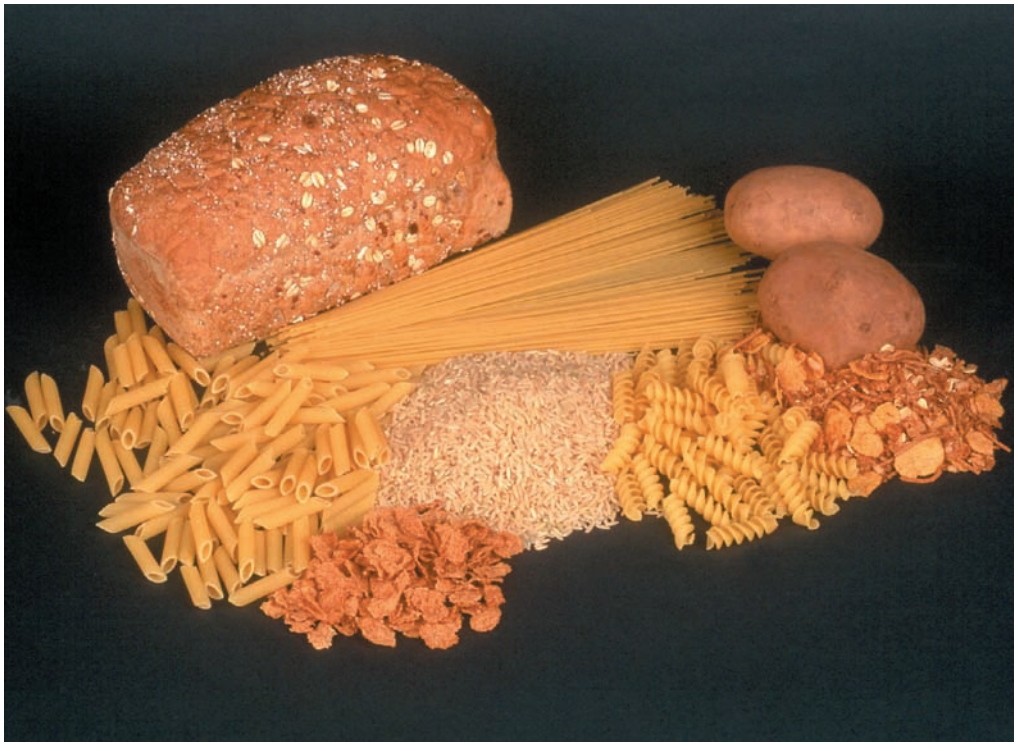


Figure 7.7 Pasta, bread, and potatoes are rich in carbohydrates. These carbohydrate-rich foods are your body's preferred source of energy. When you need energy, your body uses carbohydrates first.

DidYouKnow?

Want to increase your metabolism? Then build muscle. People with a lot of muscle have a higher metabolism because their body keeps all the muscle cells fuelled with energy. Keeping the muscles ready to work requires energy, which means that your body uses more energy — another way of saying that your metabolism is higher.

READING Check

What role do carbohydrates play in cellular respiration?

Figure 7.8 Fat is often thought of in a negative way. This is unfair. Too much fat can be a problem, but bodies need fat for good health.

Fat: There When You Need It

We need body fat for insulation, to conserve energy, and as a source of energy. Once carbohydrate stores of energy run low, the body turns to fat to power its activities. Kilogram for kilogram, fat delivers almost twice as much energy as carbohydrates do.

The **fats** we eat are classified in two groups: saturated and unsaturated. **Saturated fats** come from animal fats and from some oils. These types of fats are associated with an increased risk of heart disease. **Unsaturated fats** include most vegetable oils, such as Canola™ and olive. These fats are associated with reducing the risk of heart disease.

Dietitians recommend we have a fat intake of less than 30 percent of our daily calorie intake. They also recommend replacing saturated fats with unsaturated alternatives where possible.

Off the Wall

North Americans eat their own weight in sugar every year. Excess sugar is stored in the liver. If sugar intake continues at a high rate, the sugar is converted into fat.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2

Are all hamburgers created equal? Use the Internet to compare hamburgers from different fast-food outlets. Go to the above web site, then to Internet Connects, Unit B, Chapter 7, and then to Cholesterol.

READING Check

Why is fat necessary? What are the safest sources of fat?

Figure 7.9 These long-distance runners are training for a marathon, which is a 42 km (26-mile) run. Which athlete has more stored energy that can be burned in training? Explain when this amount of stored energy might create a problem.

Protein: The Last Choice

One gram of **protein** contains the same energy as one gram of carbohydrate. The difference is that it is harder for the body to break it down to release the energy, so it takes longer. That is why the body will use protein as an energy source only when there is little carbohydrate or fat left. Protein provides about the same energy per kilogram as carbohydrates, and about half the energy provided by fat.

Although it is a poor source of energy, protein is important for other body functions. Proteins help build and maintain body tissues. They are used for growth. That is why children, pregnant women, and women who are breast-feeding need larger amounts of protein.

Figure 7.10 Body tissue and muscles are made of protein.

When proteins are used as an energy source, however, they are unable to perform their growth and repair functions effectively. So it is important to eat proper quantities of carbohydrate and fat.

Health experts recommend that about 10 percent of our daily diet should be proteins.

READING Check

Why are proteins important in our diet?

Building Blocks

Proteins in our body are like letters of the alphabet. Letters are used to create words — they are the building blocks of our language. Proteins are the building blocks of our physical body.

Many people take proteins into their bodies by eating meat and other protein-rich foods. Most meat contains protein, which is necessary for growth and cell repair. Vegetarians do not eat meat. They must be careful that the fruits and vegetables they do eat provide them with essential protein material.

Some individuals choose extreme diets that can lead to health problems. They may severely limit food intake because of an eating disorder or to keep their weight down. This is more common in careers such as modelling, or in sports such as figure skating or gymnastics. The effects on the health and development of these people can be similar to those experienced by young people living in countries where food is very scarce.

READING Check

Why do children need more protein than adults?

Figure 7.11 This child does not get enough of any of the three essential nutrients. If she continues to be malnourished for much longer, she will be affected for life. Good nutrition later will not be able to repair the damage done during her development.

CONDUCT AN

INVESTIGATION 7-C

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Is There Energy in Common Snack Foods?

All food brings us some energy. This investigation allows you to compare the amount of energy in nuts, which are rich in fats and protein, to the amount of energy in other common snack foods. The snack foods you will test are high in carbohydrates and fat.

WARNING: If you have a nut allergy, tell your teacher immediately. You should not be in the classroom during this activity.

Problem

Which snack food contains the most energy?

Safety Precautions

- Ensure all material is fully extinguished before you dispose of it.
- Inform your teacher if you have a nut allergy.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Apparatus

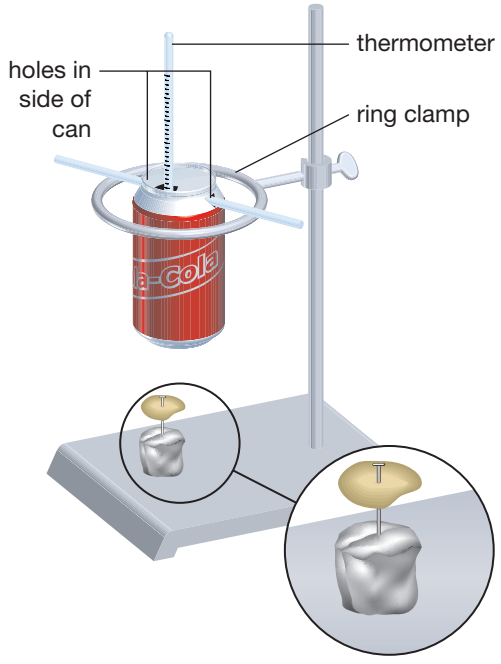
can opener
2 stirring rods
retort stand and ring clamp
400 mL beaker
thermometer
mass balance
butane lighter

Materials

empty soft-drink can
water
3 types of snack food; for example, cheesies, pretzels, potato chips
cork covered in aluminum foil
straight pin

Procedure

1. Copy the chart into your notebook. You will need four blank rows, one for each food.
2. Follow these steps to make a chamber for heating water:
   - Use the can opener to punch two holes on either side of the top of the soft-drink can.
   - Place one stirring rod through the holes.
   - Insert the can through the ring clamp so it is supported on the retort stand.
3. Use the beaker to measure 100 mL of tap water, and pour the water into the soft-drink can.
4. Use modelling clay to position the thermometer in the can. Make sure the base of the thermometer is in the water but not touching the bottom of the can.
5. Create a stand by covering a cork with aluminum foil. Skewer the food item with the pin, and then stick the pin into the top of the cork, as in the diagram.



Measuring Energy in Foods

Food Tested	Initial Mass of Food (g)	Final Mass of Food (g)	Change in Mass (g)	Initial Temp. of Water (°C)	Final Temp. of Water (°C)	Change in Water Temp. (°C)

6. Measure 4 grams of the first food item. Attach the food sample to the paper clip and place this on the base of the retort stand under the soft-drink can.
7. Measure and record the initial water temperature.
8. Position the ring clamp so the can is 4 cm above the food item.
9. Use the lighter to ignite the food item.
10. As the food burns, stir the water continuously and gently with the other stirring rod.
11. When the food sample is completely burned, note and record the final water temperature.
12. Measure and record the mass of the burned food sample.
13. Replace the hot water in the soft-drink can with fresh tap water. Repeat Steps 6 to 12 with each of the food items.

Analyze

1. Subtract the initial temperature of the water from the final temperature of each food item. Which food increased the water temperature the most?
2. Find the difference between the initial mass and the final mass for each type of food. Which food lost the most mass?
3. Was the greatest change in mass related to the greatest change in temperature? Explain.

Conclude and Apply

4. Construct a bar graph showing your results.
5. Which food contained the most energy?
6. Make a list of all the food you consumed yesterday. Identify the items on your list that may contain extra calories that your body can convert to energy.
7. Based on the energy released, which food would be a healthier snack? Explain.

Extend Your Knowledge

8. Study the food labels of several convenience foods.
   - **(a)** Are there some items that have a much higher fat content than others?
   - **(b)** Would these types of foods give off a lot of energy to heat the water, or just a little? Explain.

Check Your Understanding

1. What is the first source of energy that the body will use?
2. List five foods that are high in carbohydrates.
3. In what situations would the body use proteins for energy?

Key Terms

carbohydrate
glycogen
fat
saturated fats
unsaturated fats
protein

7.4 Human Energy Needs Change

Figure 7.12 The developing fetus is dependent on the mother. At this point in life, the fetus gets enough energy if the mother eats well. Pregnant women should check with a dietitian to make sure they are eating the proper amount and variety of foods. This will ensure their energy needs, and those of the developing child, are met.

Our need for energy changes as we go through the many stages of life, from infancy through puberty to old age.

In the picture of the developing fetus, there is a long tube called the umbilical cord. This is the lifeline for the developing child. Nutrients from the mother pass through this tube to the developing fetus.

After birth, babies are still dependent on their mothers, or another caregiver. The best nutrition for babies is breast milk. Babies can thrive on an artificial milk formula that simulates the nutrients in breast milk. The milk formula contains the necessary nutrients and minerals that give babies the energy they need to grow.

As people age, their need for energy — called their **metabolic needs** — changes. Every growth spurt and every development has its own demand for energy. For example, young people require large amounts of energy during puberty, when they increase in height, increase in mass, and mature sexually and physically. Breast-feeding mothers have high metabolism because they are providing nutrients both for their own bodies and that of the child or children they are breast-feeding.

READING Check

Explain why teenagers need more energy than adults.

DidYouKnow?

Babies who are breast-fed receive antibodies from their mother. These antibodies help to strengthen the child's immune system. Studies have shown that breast-fed babies are less likely to become sick.

Career CONNECT

Fitness instructors coach people in aerobics, weight training, and flexibility. Some also provide counselling about proper nutrition and weight control.

There is a growing interest in health and fitness in Canada. If you are physically fit, have a good sense of rhythm, speak well, and are interested in helping others live and eat well, this might be a good career for you.

An instructor usually needs training and certification from a fitness association. Each province and territory has its own set of requirements. To learn about the requirements where you want to work, call the National Fitness Leadership Advisory Council or talk to employers such as the YMCA and YWCA. Many facilities offer in-house training and certification.

Figure 7.13 As well as helping clients through exercise routines, fitness instructors give advice on proper diet and the best ways to control weight.

What Affects Metabolism?

What factors affect metabolism? There are four.

Age — Developing fetuses and young children have much faster metabolisms than adults.

Time of day — Metabolism is higher in the morning. It comes to a peak around 10:00 A.M., and slows throughout the day.

Exercise — Activity raises metabolism. The best way to lose weight is to maintain the same food intake but increase the amount of exercise.

Level of fitness — Athletes and others who are physically fit have a high metabolism because they use up large amounts of energy getting and keeping in shape.

One way to avoid gaining weight when metabolism drops is to keep active. Take long walks, swim, and cycle. Another way is to reduce food intake.

When people cut back on their food volume, they need to reconsider their dietary habits. For example, high amounts of fatty foods may increase the chance of heart disease; lack of calcium can cause brittle bones.

Figure 7.14 Thermal energy is released as the body converts chemical potential energy to the kinetic energy of motion during exercise. As a result, active people have a faster metabolism and a higher need for energy. Which of the people in this photo likely has the highest metabolism? Read the section on the left to help you answer.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2

Use the Internet to investigate the needs of athletes and their energy requirements. Go to the above web site, then to Internet Connects, Unit B, Chapter 7, and then to Athletes and Energy.

READING Check

List the factors that affect metabolism. Explain what effect each factor has.

Key Terms

metabolic needs

Check Your Understanding

1. In your own words, define "metabolism."
2. Describe some of the differences in nutrient and energy requirements between a baby and a senior citizen.
3. List three occupations in which you would expect workers to have high metabolisms.
4. For each of the following situations, predict whether the person's metabolic rate will go up, down, or stay the same.
   (a) a construction worker resigns and takes on a rural mail route
   (b) a mother stops breast-feeding
   (c) a high-school gymnast begins training for the provincial finals
   (d) a weight lifter takes time off from training

CHAPTER 7

Review

Key Terms

chloroplasts
chlorophyll
photosynthesis
cellular respiration
homeostasis
metabolism
carbohydrate
glycogen
fat
saturated fats
unsaturated fats
protein
metabolic needs

Reviewing Key Terms

If you need to review, the section numbers show where these terms were introduced.

1. Explain how chloroplasts and chlorophyll are used in plants. (7.1)

2. Explain how photosynthesis and cellular respiration are similar and how they are different. (7.1)

3. Where do saturated fats come from? Where do unsaturated fats come from? (7.3)

4. List in order the energy sources the body seeks out when it needs energy, starting with the source the body goes to first. (7.3)

5. Metabolism and homeostasis are both related to the way the body functions. What is the difference between the two? (7.2)

Understanding Key Ideas

Section numbers are provided if you need to review.

6. How do green plants capture energy from the Sun? (7.1)

7. Is all the energy produced by a plant available to the consumers that eat it? Explain. (7.1)

8. Athletes are preparing for an endurance event. Their coach tells them to carbo. load. How might this help their performance? (7.2)

9. What types of fats should you limit to help prevent the onset of heart disease? (7.2)

10. How do metabolic needs change as you grow older? (7.4)

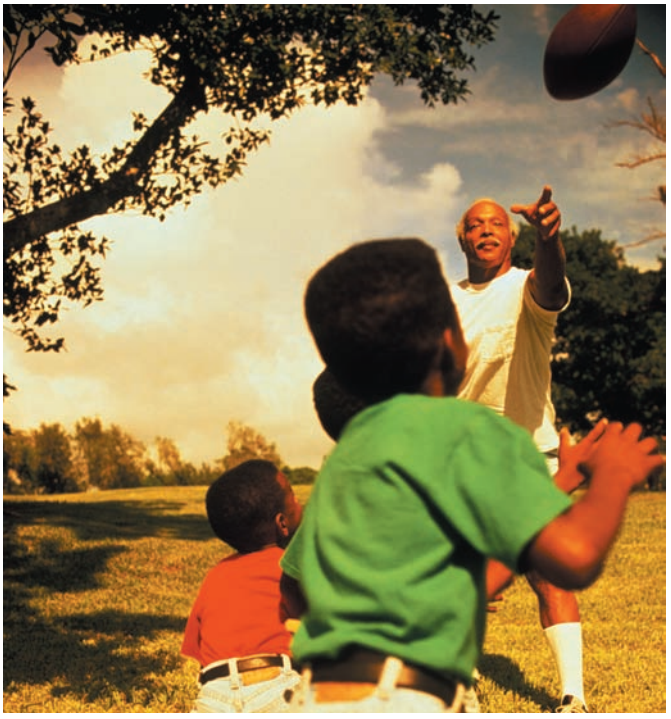
11. How does a fetus receive nutrients? (7.4)

Developing Skills

12. List the ingredients of your favourite meal. (7.3)
(a) For each food on your list, indicate whether it contains carbohydrates, fats,or proteins.
(b) How useful is this meal in terms of providing usable energy for your body?

Problem Solving/Applying

13. Your friend, a weight lifter, is trying to put on weight for an event. What would you recommend? Explain why. (7.2, 7.3)



14. Sketch a student throwing a football. In the sketch, identify the input energy, converter, and output energy. Some energy is not used for throwing the ball. What happens to this waste energy? (7.1)

Critical Thinking

15. Scientists warn that there are more obese individuals in Canada today than there were 50 years ago. (7.3, 7.4)
(a) Why do you think this is?
(b) What three pieces of advice would you give to a young person who did not want to become obese?

16. Your friend hates to eat breakfast when she first gets up in the morning. She knows breakfast is important, and she does have two periods of time when she is willing to eat it. One is just as she arrives at school. The other is during break between classes, at 10:45 A.M. Your friend is concerned about gaining weight. Which time would you advise her to eat breakfast? Explain why. (7.3, 7.4)

17. (a) Develop an activity and eating plan you could use to keep your weight at its current level. (7.3, 7.4)
(b) How would you change this program if you wanted to gain kilograms?
(c) What changes would likely assist you in losing kilograms?

Extend Your Understanding

18. You are asked to speak to students entering high school. Your topic is Eat Well for Success. You have two minutes to speak. Prepare your speech. (7.2, 7.3)

Pause & Reflect

1. Check your original answers to the Getting Ready questions on page 116 at the beginning of this chapter. Would you answer the questions the same way now? What changes would you make?

2. (a) If you had the ability to go back in time and change any of your dietary habits, what would they be?
(b) Based on what you have learned in this chapter, do you think you will be at risk if you continue your present eating habits? Explain why or why not.